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DISCOLORATION IN CANNED LOBSTERS

REPORT

OF AN INQUIRY INTO THE CAUSES LEADING TO A DETERIORATION IN THE QUALITY OF CANNED LOBSTERS

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NOTE.

Under an Order in Council dated 8th May, 1896, I was instructed to undertake an inquiry into the causes leading to a deterioration in the quality of canned lobsters This inquiry has lasted for a year and a half and is now concluded. The results are set down herein. It was commenced in conjunction with Dr. A. A. Bruère, at my request to him, and it was conducted jointly with him for a very considerable period. Then Dr. Bruère notified to me his intention to retire from the investigation. I am therefore, left solely responsible for the report in its present form, and am only too sensible of the loss to it of Dr. Bruère's able co-operation in the light of the very material value of his observations whilst he was associated with me. The present occasion is also taken to tender to him the fullest acknowledgment of his aid.

ANDREW MACPHAIL, B.A., M.D.
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216 Peel Street.

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INDEX.

	Page.
Introduction	7
Value of the Industry	7
The extent of the deterioration	7
The loss entailed thereby	7
The distribution of the loss	7
Description of damaged cans	9
Method of inquiry	9
Discoloration, its kinds and causes	10
Brown colour upon paper	10
Yellowish lustre upon seam	10
Purplish colour after bath	10
Sulphide of iron	10
Sulphide of tin	10
Oxide of iron	10
Bacteria	10
Gases	11
Theories in vogue	11
The use of acid	11
Seasonal influence	11
The question of molting	11
The question of size	12
The question of sex	13
Examination of tissue	14
The blood	14
The muscle	14
The epidermis	15
Description of present methods	15
Anatomy and physiology	15
Use of salt	16
Use of linings	16
Leaks and do-overs	16
The material for soldering	17
Soldering	17
Of the bath	17
Time of boiling in the shell	18
Use of dead lobsters	18
Breaking off alive	18
Parts most liable to deterioration	19
The quality of the tin plate	19
Bacteriology, &c	19
The remedy	22
Evidence of its value	27
Conclusion	32
Abstract of process	32

INTRODUCTION.

Before undertaking this inquiry, it was necessary to measure the importance of the work in hand, to ascertain the amount of labour it would be thought advisable to bestow upon it. This problem was approached from various sides.

1st. The value of the industry.
2nd. The extent of the deterioration.
3rd. The loss entailed thereby.
4th. The distribution of the loss.

The following facts are therefore submitted, because it was the consideration of them which pointed to the necessity of an extensive and elaborate research. If any results were to be obtained, it was only by proceeding in an orderly manner and to great lengths, if necessary. Even if no results were to be arrived at, the preliminary work would have been done for some more fortunate observers. Therefore, the inquiry was projected upon a wide and sound basis, and the various operations are set forth along with the conclusions to which they led.

I.—VALUE OF THE INDUSTRY.

Statistics are available in a supplement to the twenty-fifth annual report of the Department of Marine and Fisheries. In it the Deputy Minister states that the number of cans packed in Canada that year was 14,285,157, or nearly 300,000 cases, which at the nominal price of $8 a case amounted to $2,400,000.

The value of the export of lobsters in		1891 was.....	$1,930,175
do	do	1892 was.....	1,909,756
do	do	1893 was.....	2,071,225
do	do	1894 was.....	2,331,660
do	do	1895 was.....	2,135,756
While last year the value amounted to.....			2,489,995

The average price per pound in 1883 was 9·12 cents ; in 1893 it had risen to 14·10 cents ; at present it is 18·72 cents.

(2.) The extent of the deterioration.
(3.) The loss entailed thereby.
(4.) The distribution of the loss.

These three factors will be considered together.

It is a matter of exceeding difficulty to estimate accurately the annual loss sustained by the industry through deterioration in the quality of the goods, by blackening and other causes, because the loss falls in so many quarters.

First, there is the loss to the individual packer ; then to the buyer, the wholesale merchant, to whom the goods are sent, to the retail dealer, and finally to the consumer who probably bears the bulk of it, and whose loss can never be ascertained.

To obtain some expression of opinion, a communication was addressed to packers, buyers and dealers in the Maritime Provinces of Canada, the United States, and Great Britain.

It contained two questions :

1st. What do you consider to be the causes of the depreciation in the quality of canned lobsters ?

2nd. What, in your opinion, is the annual loss to the lobster packing industry through this deterioration ?

From some of the factories came replies that they sustained no loss whatever. This fortunate condition is explained by the fact that those packers market their goods twice a week before any considerable change is manifest, receive their money, and the transaction so far as they are concerned, is finished. The first buyers ship the goods on commission and receive what the consignee can afford to send. This then is a source of information. In this connection, the following extracts selected from many letters are of value as showing the feeling of the trade in England :

From W. & D. Harvest, Dowgate Dock, Upper Thames St., London, E. C. :

"We trust the experiments you allude to may produce satisfactory results. Certainly, the present canned lobsters form so capriciously perishable a stock that the trade is avoided as much as possible by importers, dealers and retailers."

From Messrs. Crosse & Blackwell, Soho Square, London :

"There is a great need of improvement in the preservation of lobsters, as there have been special difficulties in the past few years."

From Petty, Wood & Co., Nos. 41-57 Southwark Bridge, London, S. E. :

"We think it is quite time some steps should be taken by the Canadian Government to regulate and try to secure the packing of fish which are sound and fit for the food of man and also to stop the shipment of rubbish and unsound food."

From Powell Bros. & Company, No. 27 Mincing Lane, London, England :

"The whole industry for years past has been going from bad to worse owing to the unsatisfactory out-turn of the major portion packed : in fact, to such a pass has it come that many firms have repeatedly expressed to us that they will need to seriously consider abandoning the sale of canned lobsters, owing to the unpleasantness and difficulties in which they are so constantly involved."

From the Cunningham & DeFourier Company, Limited, Great Alie St., London, England.

"It is our opinion that unless some prompt action be taken, the trade in these goods will practically cease as regards Great Britain.

"For our part, we have made up our minds to discontinue offering lobster next season unless we can see an improvement in the pack, as the complaints which come to hand and which we have to satisfy by allowances, make the business very troublesome, and it is doubtful, taking all things into consideration, if we make any profit by handling these goods."

From Samuel Hanson, Son & Barter, No. 47 Botolph Lane, London, England :

"There is no doubt whatever that unless something is done to improve the packing, the trade in canned lobsters, which has already seriously declined, must go from bad to worse, to the injury of all concerned."

From A. W. Latham & Co., No. 17 Philpot Lane, London, England :

"If this blackening can be removed, it would be an enormous value to this industry for at present, the marvelous uncertainty as to whether, lobsters, from wherever they may come will show smut or turn black sooner or later, is one of the courses of this trade leading to endless difficulties and creating all sorts of dissatisfaction : in fact, if we were not obliged to handle lobsters, we should strike them off our list and thereby save ourselves much worry and loss."

The replies received from Mr. J. E. Grant and from Mr. W. F. Tidmarsh of the Portland Packing Company are to the point. In his reply Mr. Tidmarsh says: "I think I would be quite safe in saying that if the 'blackening' so called, could be prevented, and the lobster preserved so as to retain its colour, flavour and texture, when the confidence of the trade became established, the value would be increased by at least three dollars a case, representing a total in money value to the industry in Canada of about $900,000 per annum."

Messrs. Macdonald & Bros. estimate the loss at two dollars a case, which according to the annual output is equal to $600,000 a year.

Mr. Grant in his reply says :

"It is very difficult to answer your inquiry fully, as the loss does not frequently fall upon the packer, he realizing on them through the dealer, who ships them to the different markets of the world, and who in reality meets with the first loss and

ultimately the jobbers who buy them at a price and keep them in stock awaiting the demands of the trade. Some seasons I know the jobbers lose all their goods. As a dealer I can speak very feelingly and can say that I have lost thousands of dollars by shipping lobsters on consignment. The only certain method in handling lobsters is to get rid of them as quickly as possible. It might be interesting to you to know the actual commercial value of a choice can of bright lobsters. Few realize the fact that the choice parts of eight lobsters go to fill a one pound can.

"The consumer thinks nothing of paying 12½ cents for a fresh lobster. Multiply by eight and the can of lobsters show a value of one dollar. Now, if the canning of lobsters could be brought down to an exact scientific process and the consumer could be guaranteed that the goods were as good as when fresh, the question will answer itself."

As long ago as 1887, Inspector Duvar wrote:—

"Owing to the inferior grade of goods prepared by some packers, the lobster business is in great danger of being seriously imperilled. Canadian packed lobster is at a very low ebb in English markets, so much so that London green-grocers will have nothing to do with Prince Edward Island lobsters on account of their inferior quality."

From this it is clear that the loss is a very material one, not only in the deterioration of the present product, but from the fact that the best quality now produced is inferior to that which should be obtained and can be obtained by the adoption of scientific methods."

DESCRIPTION OF DAMAGED CANS.

This deterioration in the quality of the contents of cans is variously referred to as "blackening" or "smut," and other cans are known as being "sour," "acid," "fermented" and "blown." This points to the fact that the deterioration manifest itself in various forms and is due to widely different causes.

It will first be necessary to describe the appearances presented by a series of damaged cans. Upon opening a large number it was at once seen that there was the largest possible variety of condition. Indeed the discoloration was absent in many cases and the degree to which it had proceeded was different in all. In some the contents were uniformly dark, the colouring matter penetrating the whole tissue. In others it was confined to that portion which was in contact with the seam of the can, and at the junction of the cover and bottom with the two ends of the cylinder. Again it occurred in spots corresponding with the puncture made in the cover to allow the air to escape or to assist in the process of sealing. In these places the continuity of the tin coating was broken, allowing the middle plate of iron to come in contact with the contents. Again, the discoloration commenced over small areas where the tin was eroded, but whether this erosion was due to a primary defect in the material or whether it was due to some solvent action of the contents had to be reserved for further examination and will be referred to latter. In some cases the paper lining was alone discoloured and in others a space along the seam of the can.

In most instances the contents remained solid though discoloured. Some were liquid and uniformly black and others liquid but of a normal colour. Many cans were bulging almost to the point of bursting with gas, and when punctured the gas escaped with a rush and foul odour while in others the amount of gas was imperceptible.

METHOD OF INQUIRY.

We are now able to define the scope of the inquiry as follows:—

1. To classify and describe the different forms of deterioration.
2. To ascertain their causes and consider the various theories in vogue respecting them.
3. To determine whether they began to operate before or after the process of canning commences.
4. To consider the present methods.
5. To provide a remedy and prepare a scheme for the profitable preservation of lobsters.

DISCOLORATION AND ITS CAUSES.

First of "blackening." This should be described as "discoloration," for the colour varies from a faint brown, a brilliant purple, a luminous yellow to a condition of inky blackness.

Of this discoloration we have separated seven different kinds all due to different causes which are here described in detail.

1. Brownish discoloration of the paper alone.

This form was found to be due to merely to scorching with an overheated copper too long applied. To determine this a can empty except for the lining, was sealed with a very hot copper, on opening, the paper was found scorched as described. Again a similar discoloured area was removed from the lining of a can and treated with hydrochloric acid. The colour was not removed, proving it was due to organic destruction of the paper by heat, and of no serious moment excepting in respect of appearance.

2. A yellowish discoloration of metallic lustre along the seam of the can.

This is observed in many cans newly made and before the lobster is introduced and is due to excessive heat in the soldering of the can itself, as can be shown by applying an overheated copper for an unusually long time to a piece of tin plate when a similar result is produced.

3. A purplish discoloration observable immediately after the cans are removed from the second bath, which will be dealt with in considering the "Remedy."

4. SULPHIDE OF IRON.

In another series a blackness as intense as that of ink was observed commencing where the raw edge of iron was exposed along the seam, around the covers and at the probe holes. This gradually extends to the contents of the can. This substance is soluble in hydrochloric acid and yields a precipitate of sulphur. When filtered and diluted with distilled water and a stream of sulphuretted hydrogen passed through, no precipitate is obtained, indicating that no lead or tin is present. If tin were present we would have a brown precipitate and black in the case of lead. If, now, ammonium sulphide be added, a black precipitate is brought down which is soluble in hydrochloric acid, and with potassium ferrocyanide yields the reaction of a ferrous salt. This discoloration then is due to sulphide of iron, and is caused by the sulphuretted hydrogen acting upon the iron. The sulphuretted hydrogen arises from the putrefactive fermentation of proteid matter, under the influence of micro-organisms, as will afterwards appear.

5. SULPHIDE OF TIN.

This produces a uniform brown tinge upon the paper. This material when treated with hydrochloric acid and sulphuretted hydrogen, produced a brown precipitate of protosulphide of tin, which dissolved in sulphide of ammonium, giving sulphide of tin ; when acid was added a yellow instead of a brown precipitate was separated. This is the reaction of a stannous salt, the sulphide of tin being formed in the same manner as the sulphide of iron.

6. OXIDE OF IRON.

A yellowish brown rust upon the raw edges of iron due to common oxide of iron. A can was filled with a solution of salt and water and boiled for three hours, when a similar condition was produced. The material from the can answered all the tests for oxide of iron, that is to say, caustic alkalies gave a brick red precipitate of ferric hydrate insoluble in hydrate of potassium ; ferrocyanide of potash gave a blue precipitate, and sulphocyanate of potash gave a deep red colour.

7. BACTERIAL ACTION.

Discoloration due to bacteria. In many cans which are in the early stage of putre faction one observes colonies of bacteria upon the surface of the contents giving a uniform brownish tinge. This may be scraped off, leaving the tissue beneath of normal colour.

From the foregoing it will appear that the ultimate source of a large series of discolorations is the presence and operation of bacteria.

It was therefore clear that an exhaustive bacteriologic study would have to be undertaken. To this end, it was necessary to establish a laboratory where abundant material was accessible. Accordingly in May, 1896, this was done in Charlottetown, Prince Edward Island, with all the necessary appliances. The work was continued there till the latter part of June, and recommenced early in July to investigate some matters which were overlooked during the first visit.

GASES.

The sign of deterioration most eagerly sought for is a bulging of the ends of the cans due to an accumulation of gases within. These gases are a product of bacterial activity, and upon analysis were found to be composed chiefly of :—

Sulphuretted hydrogen. Carbon dioxide.

The material from which sulphuretted hydrogen may be readily formed, is often introduced into the can by the non-removal of the gut and its contents. The stomach and gut of a living lobster were placed in a test tube with acetate of lead paper, within six hours sulphuretted hydrogen was developed in appreciable quantity and rapidly discoloured the edges of the plate placed in contact with it.

THEORIES IN VOGUE.

Among the numberless theories as to the cause of "blackening" of lobsters the use of acid easily holds the first place. Now, as a matter of fact, if a portion of lobster tissue be immersed in pure hydrochloric acid for a few days it becomes beautifully white. Therefore, the use of acid in the manufacture of cans has been almost abandoned, and much ingenuity has been displayed to procure a suitable substitute. The general consent is in favour of employing a mixture of rosin and linseed oil. Another preparation is made as follows : "add one pound melted rosin to a gallon of lard oil, and stir to the consistency of cream." The effect of strong acid upon the tin is of course to dissolve it, but when tin is etched by a dilute acid the effect is to dissolve the minute crystals more quickly than the larger ones, giving to the surface a frosted appearance (moirée métallique.)

SEASONAL INFLUENCE.

To determine what influence, if any, the time of year in packing exercises. Small packs were made in the following months : May, June, July, August, October and December. Upon examination of cans packed at these various periods it was not possible to observe any difference in quality in respect to colour.

THE QUESTION OF MOLTING.

It is worth inquiry if there is any connection between the deterioration and the molting of the lobster, but before doing so, it will be necessary to discuss the details of the process by which the shell is cast.

All shell-fish grow in stages. They are surrounded by a hard inelastic covering, and when in the process of growth this covering becomes too small, it is cast off. This is known as molting. The process was well studied by Vitzow in the marine laboratory of Roscoff, and by Francis Hobart Herrick in the laboratory of the United States Fishery Commission, at Wood's Hole, Massachusetts, from whose excellent report many of

these physiological statements are taken. The shell of a lobster varies in hardness and colour, depending upon the period since the last molt. An animal which has recently cast its shell is known to fishermen as a "soft shell," "new shell," "paper shell," or "buckle shell" lobster, and just previously to molting as an "old shell," "hard shell," or "black shell."

In Prince Edward Island it is unusual to obtain soft shell lobsters before the middle of July, at which time a few may be found in the traps with the cast off shell by their side, or the shell alone may be found, the animal having escaped by reason of its smaller size. The newly molted lobster lies limp and helpless, but is covered by a limiting membrane, resembling in shape at least, in every respect the shell itself. Not only is the shell cast off but the lining of the stomach, œsophagus and intestine is exfoliated as well, these structures being derived from infoldings of the skin. Water is now quickly absorbed and the flesh converted into a pulpy mass. There is now a marked increase in size and a rapid hardening of the new shell.

Many factors go to account for this rapid growth of the shell. On each side of the stomach of a molting lobster are found two bodies an inch long and half an inch thick, composed of calcareous matter and known as gastroliths. These bodies may be, as Vitzow suggests, "dissolved in the acids of the stomach and entering the lymph form an inorganic reserve comparable to phosphatic plaques found in the membranes of the fœtus in ruminants." On the other hand Herrick may be right in holding that these gastroliths "represent the lime which has been removed by absorption from the old shell preparatory to the molt." But there is a more obvious source of supply of the calcareous matter necessary for the formation of the new shell. After molting the lobster is in the habit of swallowing fragments of shell, which are changed in the stomach to acid phosphates and thence carried by the blood to the locality where they are needed. It is difficult to say what period must elapse before the shell acquires any considerable degree of hardness. Reaumur, speaking of the crayfish, says that he has seen the new shell become as hard as the old in 24 hours, but that it usually requires from two to three days; and Chartran, referring to the same animal, says he has seen the shell resume its normal consistency in 48 hours. Vitzow admits that the carapace has become perceptibly harder in 24 hours, but that 72 hours must expire before it is completely so. It would seem that in the case of the lobster, there is a considerable variation in the time required, and that it is not marketable for at least a month.

Now, from experience, the condition of the flesh has no bearing upon its deterioration in the cans. The most that can occur is a slight alteration in the flavour or consistency of the flesh.

THE QUESTION OF SIZE.

It remains yet to consider what bearing the size, and, therefore, the age of the lobster has upon its value as a preserved food.

We have now to inquire what are the data from which the age of a lobster may be determined. The age can scarcely be determined by direct observation, since the conditions of confinement, food supply, temperature, &c., probably introduce variations which will render any conclusions fallacious. By observation, Herrick found that one yearling lobster which had been hatched from the egg measured $1\frac{3}{5}$ inch, while three others measured 2 inches in five months. He has constructed a table from which it appears that the increase in length after each molt is about twelve per cent of the previous length, or one-eighth, that is, an eight-inch lobster would measure nine inches after molting. If now the number of molts and the time interval could be ascertained, some conclusions could be drawn. In another table he estimates that a 2-inch yearling lobster has molted 14 times, a 5-inch lobster 20 times, an adult lobster 10 inches long, 25 times. This leads him to the conclusion that a 10 inch lobster is from $4\frac{1}{2}$ to 5 years old. It will be seen then that the lobster is an animal of rather slow growth.

An examination of the tissues of lobsters five or six inches long discloses nothing which makes one think them unfit for canning. The expediency of so using them is another question.

QUESTION OF SEX.

We have now to consider whether the sex of the lobster has any bearing upon the deterioration of the canned product. By way of preface to this consideration, a short statement of the sexual habits of the lobster will be necessary.

There is a complete separation of the sexes. The female is smaller in size, the claws are less highly developed. The abdomen is broader and more concave. The first pair of swimmeretts is reduced in size to admit of the more complete flexing of the abdomen for the protection of the eggs.

The organs of reproduction are, (1), the ovaries, consisting of two masses of tissue connected by a bridge and situated in the dorsal region, extending from the middle of the carapace to the fourth or fifth abdominal segment. Just previous to laying, the ovaries are seen filled with eggs, which may be removed by cutting into the wall. (2.) Two short tubes leading from the ovaries and opening into (3) two small slits upon the basal segments of the second pair of walking legs. (4.) The receptacle for the fertilizing element of the male situated between the third pair of legs. (5.) Glands which secrete a cement substance for securing the eggs, after they have been laid, to the abdominal appendages. The male lobster possesses a pair of testes, opening by ducts at the base of the last pair of walking legs, and the first pair of abdominal legs are modified as if to serve for conducting the fluid, which is inclosed in gelatinous capsules, into the seminal receptacle of the female.

The pairing of lobsters may take place at any time of the year and apparently has no connection with the condition of the ovaries of the female. The seminal fluid can be obtained from the receptacle of the female independently of the time of laying, hatching, or even molting. The male element is stored up until needed, and retains its vitality for a very long time.

There is a conflict of evidence as to how often the lobster lays eggs, when they are laid, and how long they are carried externally.

It is quite true that lobsters may be taken at all seasons of the year, with the eggs in all stages of development, but this does not affect the main statement that, for the majority of lobsters, there is a definite breeding season. The process of laying is as follows: The eggs are extruded from the body after being carried about a year, and are fertilized by coming in contact with the spermatozoa ready stored up in the seminal receptacles of the female. The tail is folded in, and the eggs are attached to the swimmeretts by means of a cement substance secreted in special glands, and there carried for about ten months. The lobster is now said to be in "berry." Then the embryos escape as free swimming animals in the ocean. The number of eggs is very large, a twelve inch lobster producing about fifteen thousand. Seeing then, that the female lobster spends the most of its time in the business of reproduction, it is very important to decide its value as a food supply, especially since the number of males and females is probably equal.

First, lobsters can never at any period of life be compared with fish bearing their roe, because the eggs ripen over a period of two years, and there is no spawning time, comparable in point of intensity with that which obtains in the case of fish.

In the report of the English Fish Commission presented in 1877, it is stated that "the lobster when in berry is in the very best possible condition for food." The only evidence adduced is the fictions of fishermen and cooks. The fishermen wished to continue catching the female fish, and the cooks lusted after the eggs for the garnishing of salads. One witness remarked with the real fisherman's wisdom "lobsters in berry are worth twice as much as any other, the spawn is bruised and put into sauce and makes better sauce than the lobster itself. In salads it is boiled and sprinkled over the salads; it is a capital article of food. The cooks will not have the lobsters without spawn." Upon such information as this, and with logic like a fisherman's, the Commissioners are led to remark "it would be as illogical to prohibit the taking of lobsters in berry as to prohibit the taking of full herring."

On the other hand, Herrick shows that a lobster in berry is actually lighter than a female not carrying external eggs, by an average of 1·63 ounces.

In the case of smaller lobsters, the difference was found to be only a tenth of an ounce. The males are heavier than the females, but this is due to the larger size of the claws. The matter was put to the test, and as between a male lobster, a female in berry and a female carrying no external eggs, the most delicate palate can detect no difference in the flesh. Lastly, there is no difference in the tendency to deterioration after canning between these three classes.

EXAMINATION OF TISSUES.

To arrive at a conclusion as to whether lobster tissue was in a normal or pathologic condition, it was necessary first to make a preliminary study of a large number of animals to be used by way of comparison. These observations were confined principally to the muscular tissue and to the blood. A detailed account of this division of the work would be out of place here; and only so much introduced as is necessary for the main purpose.

THE BLOOD.

A number of good-sized animals were secured, and by means of a deep puncture through the membrane connecting the second and third joints of the crushing claw, the blood was allowed to escape, as it did in a considerable quantity. The amount depends upon the size of the animal and the thoroughness with which the operation is done. As the blood issued it was slightly viscous, but soon coagulated into an opalescent clot, in thin layers transparent, but when seen in sections of considerable thickness, opaque, from the presence of flaky masses. From the instant of shedding, a bluish coloration appeared on the surface, at first light blue, then of a rich indigo tint. This colour extended downward into the substance of the clot in a regular layer of about one-third its thickness, and after a time the whole mass changed to the same colour, with the exudation of a dark-coloured serum.

This colour disappears on heating to 100° C, in a water bath, also by the addition of hydrochloric acid or hydrogen peroxide, leaving the clot opaque and of a pearly lustre. When further heated it assumes a brown hue, which, however, is limited to the surface. The blue colour does not return on cooling if the clot is protected by water, but on exposure to air, there is a slight reappearance. The colouring matter is not soluble in chloroform, ether or peroxide of hydrogen, nor upon spectroscopic analysis does it yield any absorptive bands, though there is a general dimming of the whole spectrum. This colouring matter is a respiratory pigment *hæmacyanogen* and well deserves further study. The microscopic examination of the blood which was made with $\frac{1}{12}$ objective and a No. 4 ocular revealed white blood corpuscles much larger than those of the mammalia, with round sharply defined margins, or irregular with sinuous edges. The protoplasm granular and staining faintly with methylene blue, the nuclei salient either simple or compound with well defined nuclear membrane and staining deeply. In many cases, the cells were multinuclear. The blood also showed fibrin threads and granules, but no appearance of coloured corpuscles or micro-organism.

THE MUSCLE.

The muscle substance is composed of fibres in bundles, as in the case of the crab, the bundles separated by fibrous connective tissue, the fibres striated showing alternate dim and light stripes, in this respect also resembling the muscle of the crab, but much broader than in the mammalian muscle. In the physiologically extended fibre, the light stripe is almost as broad as the dim stripe. In the centre of the light stripe, there is a well marked line or membrane known as Dobie's line or Krause's membrane. This line seems to consist of a row of granules. On each side of Dobie's line and midway between it and the border of adjacent dim stripes is another faint line corresponding with the lateral disc of Engleman.

In fully contracted fibres the light stripe is much narrower than the dim one. The centre of the dark stripe appears comparatively clear and reveals the presence of a membrane like Henson's membrane in the dark stripe of the crab's muscle.

Besides the transverse striation there is a longitudinal striation due to the presence of fibrilles. Histologically then, the muscle of the lobster is almost identical with that of the crab.

EPIDERMIS.

The epidermis covering the surface, and from which the shell is secreted, is composed of epithelial cells, containing a pigment soluble in ether, and chloroform. On evaporation of the ether, an oily residue remains pigmented red, which, when combined with alkalies, forms a soap.

DESCRIPTION OF PRESENT METHODS.

It will be necessary to give some small description of the methods at present employed in the lobster packing industry. It should be said in the outset that those engaged in the industry are using their best efforts to secure satisfactory results and that any failure is due to causes entirely beyond their knowledge, and all those with whom we came in contact showed a disposition to do everything in their power to forward the investigation. At the same time, in many cases the wonder is not that the canned product is so bad, but that is as good as it really is. Many of the factories are mere hovels with inadequate appliances for ordinary cleanliness, and under the best conditions it is to be remembered that the quantity and kind of offal connected with the process is admirably suited for the growth of putrefactive micro-organisms. The factories are seated upon the shore with stages leading into deep water for the accommodation of boats, or the buildings themselves are at the end of a stage connecting with the shore. Here the boats come laden with lobsters from the traps, and they are then counted out. They are shovelled into casks and at once thrown into a vat and boiled. The time during which they are boiled is said to be about fifteen minutes, but by actual test of many cases, we found it to be nearer half an hour when all the lobsters were out. They are then thrown upon large tables to cool, and when cool are "broken off" that is, the body is broken from the tail, and the claws removed by striking against the side of a barrel into which they fall.

The tails are taken to the "tail table" and the meat either "punched" or "pulled." That is, either pushed out from behind with a suitable instrument, or pulled out in front with a fork. The latter method is preferable, as otherwise the last segment of the tail is apt to be broken off. The claws are cracked and the meat shaken out: the "arms" are split longitudinally and the "arm-meat" pulled out with forks. Next the tails are split and the gut removed. This splitting may be done upon the "front" or back. Front splitting is preferred since it does not interfere with the contour of the body. The blood which has coagulated in the claws in boiling is removed by washing in sea-water, and the tails are cleansed in the same way, care being taken to remove as much of the "green-gland" as possible, which in boiling has tinged the upper part of the tail. The meat is placed in strainers, and soon is ready to be packed. The cans are of two sizes, half-pound and pound: of two shapes, tall or flat. So there are "pound-flats" and "pound-talls," "half-pound flats" and "half-pound talls."

As the lobsters which are taken are becoming smaller year by year, it takes an increasing number to fill a can. The average now is about six to a pound.

The cans are lined on the bottom and sides with vegetable parchment of suitable shape. The tails are curled up and placed in the bottom: then comes a little arm meat, and the claws are laid in rows on top. Salt has to be added, and one has heard much discussion as to whether it should be put in first or last, whether dry or in the form of pickle. The meat is "pressed," the can "wiped," the paper lining is put on and finally the can is covered. The cans are now given to the sealer, and an expert workman will seal a thousand in a day. When the day's catch is in the cans, the "bathing" begins. A huge vat is filled with water and kept boiling by a fire of hardwood in a brick furnace. The cans are placed on trays and swung in by means of a crane. The practice of packers differs, but the average length of the first bath is one

hour and a half at the temperature of boiling water. The cans are hoisted out and the trays placed on a rack. Then the sealers puncture each can with a small mallet having a sharp point in its face, the steam and air rush out and then the opening is sealed. The ends of the can are now "concaved" by atmospheric pressure. This operation of puncturing the cans is variously designated, some referring to it as "probing," others as "brobing" or even "broging" but as philology was no part of the present inquiry, the matter is left in abeyance.

The trays are again introduced into the boiling water where they remain for another hour, and are then allowed to cool gradually. The pound cans are packed 48 in a case, and the half-pound cans 96 in a case.

For the employees, men and women, the business is not unpleasant. The work is not laborious, the pay is good, and on stormy days and wet they have good leisure to indulge their propensities, which sometimes unfortunately run in undesirable channels.

The food is abundant and good, if not very delicate, nor the cooking of it over dainty.

USE OF SALT.

To preserve the characteristic flavour of the lobster, all are agreed that salt should be added, and as salt and water are cheaper than lobster, there is a further inducement for its employment. The usual amount is an ounce of pickle to the one pound can, which is included in the weight, and is therefore six per cent of the whole, a valuable margin of profit. In some markets the buyers specify that the meat shall be packed in dry salt. The best practice seems to be, instead of pressing the water out of the lobsters with a heavy weight, to allow them to drain by standing in perforated tins, and add the dry salt. Now, as one part of the salt is soluble in about three parts of water, it follows that an ounce of saturated solution is equal to about a third of an ounce of salt. Two teaspoonfuls, therefore, of dry salt seems to be the proper quantity to be added to a pound of lobster.

USE OF LININGS.

Linings of vegetable parchment were introduced four years ago as a remedy against blackening, the object being to protect the meat from contact with the tin. The practice has led to no improvement so far as can be learned. The device is pretty; the lining gives a pleasant appearance, and as it costs less than lobster tissue, it is likely to be retained. Yet, if scorched in soldering, or if the edges slip in between the cover and the can, it is a serious disadvantage.

"LEAKS" AND "DO-OVERS."

When the cans are removed from the first bath the ends are convex owing to the expansion of the heated air and steam within. If, however, there is a leak in the can there will be no expansion, and when punctured the can will not "blow." As soon as the can is punctured and sealed the ends are concave. Again, after the second bath, if there is a leak in any can this concaving has disappeared and is replaced by convexity. Such a can is known as a "leak." The test is applied by tapping the tops of the cans with a bit of metal, a nail or a piece of solder, and the "leaks" so discovered are set aside. This test is of very uncertain value, as the note varies with the fullness of the can, and the proximity of the contents to the cover. A number of cans which were declared by packers to be "leaks" were secured and set aside unmended. They were found to be sterile after three months. These "leaks" are then "mended" and re-bathed for half an hour. These cans are known as "Do-overs," and are considered of inferior value. Only a limited number are placed in each case. The percentage of "leaks" will depend on the care exercised in making the can and in the soldering of them, but the average seemed to be from three to five per cent. There seems to be no necessity for having any imperfectly sealed cans, since out of five hundred cans put up and sealed by us with only ordinary care not one turned out to be a "leak." Now, according to the principles to be afterwards laid down, if a leak should occur it is to be

mended at once, and the process of "bathing" is to be commenced from the first, instead of merely boiling the can for half an hour, which, as we know, is insufficient to destroy such micro-organisms as may enter. Such a "do over" would then be subjected to twice the ordinary amount of heat, and the contents might be injured thereby, though possibly to no great extent. Even this possibility might be avoided by care in sealing.

THE MATERIAL FOR SOLDERING.

Many makers have secret mixtures often purchased at great cost. As a matter of fact the use of rosin gives no additional advantage. It renders the manufacture of cans more difficult, and worst of all, the surplus rosin cannot be removed without some solvent, and it remains around the edges of the cans in a thick deposit. The result is, when the can is boiled, the rosin volatizes and permeates the tissue with its odour.

Again, shall the bottom be soldered upon the outside or the inside of the can? This is a pure matter of convenience, though in some countries there is a regulation that all cans shall have the bottoms upon the outside on account of a whimsical belief that the danger from lead poisoning is lessened by this manœuvre, solder being an alloy of lead and tin.

SOLDERING.

It is in the soldering of the cover that the lobster packers' fancy has an opportunity of exercising itself. Packers who were willing to yield up all their "secrets" would hesitate to reveal the nature of the "flux" they were using. Some affected to find virtue in a saturated sponge. The main thing is that whatever material be used—and there is nothing better than the ordinary "salts of lemon" it should be used in moderation, and not allowed to flow down upon the contents of the can. In many cases the copper employed was too large, and conveyed the heat to the interior of the can. The crescentic shaped soldering irons for this reason are objectionable.

OF THE BATH.

In three of the largest factories the heat is applied to the cans in iron retorts by the use of live steam. In the early part of the inquiry, as will afterwards be explained, the principles as laid down by Pasteur for the sterilization of media were applied and had to be abandoned. Upon this basis the use of steam retorts would have been invaluable. But since it is useless dealing with a temperature of less than that of 100° C. the necessity for steam retorts no longer exists. The method of using the retorts at present is faulty, because too high a temperature is employed. It is the custom to introduce steam till the pressure gauge registers fifteen pounds to the square inch, and as the gauge does not begin to register till the atmospheric pressure of 14 pounds is overcome, an actual pressure above the vacuum of 29 pounds is being used. According to Regnault's tables this is to be translated into a temperature of 248° Fahrenheit which is too high for any tissue intended to be used as food. Besides as high a temperature is disastrous to the tin. In any tin crystal the co-efficient of thermic expansion has one value in the direction of the principal axis, and another in that of the subsidiary axis. Above 213° F. they assume different values, and as the crystals are oriented in a lawless fashion they tend to disintegrate. At the same time steam retorts may be used and fitted with a thermometer instead of a gauge, and the steam introduced without pressure.

The following is an abstract of Regnault's table reduced to Fahrenheit scale:

Gauge showing lbs. per sq. in.	Temperature F.
0	212
1·3	216
4·3	225
8·3	235
10·3	240
11·3	242
15·3	250

TIME OF BOILING IN SHELL.

To determine the length of time for which lobsters should be boiled the following experiment was made:

Six lobsters were placed in boiling water and one removed in five, ten, fifteen, twenty, twenty five and thirty minutes respectively. The one first removed was only moderately red, it could be broken off easily, but the meat was rather difficult to shake out. The lobster which was boiled for ten minutes was in perfect condition for dealing with, and all the others were unnecessarily boiled. Now it is clear that the least possible amount of boiling should be given in the shell to allow of a maximum amount of heat being applied to the can for a definite purpose, and without damaging the tissue by too prolonged application of heat. The actual time required will depend upon the size of the lobster and the thickness of the shell, but a lot of seventy was selected above the medium size and boiled for ten minutes with perfectly satisfactory results.

How long after removing the lobsters from the traps may they be allowed to remain alive before boiling?

To this question no answer can be given, because it depends upon the length of time during which they remain alive, and this depends wholly upon their surroundings, such as temperature and cleanliness.

Upon ice a lobster will live for many days and may be transported long distances, and upon a clean floor at ordinary room temperature it will live for twelve to twenty hours. But if the day be warm, if the lobsters be closely packed, especially in an unclean boat, death comes very quickly.

USE OF DEAD LOBSTERS.

Another very important question is:

May lobsters which have died before being plunged into boiling water be used for canning?

To determine this six lobsters were killed by forcibly breaking up the cervical ganglia. One was examined histologically at once and the others after four, eight, twelve, sixteen and twenty-four hours respectively, with the following results:

Lobster just dead, muscle teased out in eosin examined in Farrant's solution 350, shows fibres with white fibrous connective tissue, striped, with Kraus's membrane and Henson's line, healthy.

Tissue of lobster dead four hours teased in acetic acid, mounted in Farrant's solution by 360, muscle fibres healthy.

Lobster dead eight, twelve, sixteen, twenty and twenty-four hours respectively, muscles in good condition, no evidence of degeneration in sarcous substance, 350 no micro-organisms. (Methylene blue, mounted in Farrant's solution).

Lobster sixteen hours after death, raw and boiled, tissue perfect.

Lobster dead twenty-four hours, though the tissue looks perfect, microscopically the transverse striæ are rather faint, indicating that the limit of post-mortem changes has been reached. The limit of use then, appears to be twenty-four hours at 17 C. to 20 C.

Female lobster in berry sixteen hours after death, tissue perfect.

"BREAKING OFF ALIVE."

It is held by many that there is great efficiency in breaking off alive, that is, separating the tail and claws before the life of the animal is destroyed by boiling. By this device the blood is allowed to escape. Now, in the first place, there is by this method a considerable loss, since a fair-sized animal yields at least four ounces of blood, yet in any case a considerable amount of blood is lost in boiling, when it appears as a coagulum about the base of the claws and in the arms. To determine the value of this belief a number of lobsters were taken and the claws and tails separated whilst the animals were living. These were packed in cans and when opened no difference could be detected as compared with the usual method of boiling the lobsters and separating the parts afterwards.

PARTS MOST LIABLE TO DETERIORATION.

To determine whether one portion of the animal is more liable to deteriorate than another, a number of cans were packed with claws alone, and others with tails alone. No difference could be observed in the results. There is always, however, even in boiled uncanned lobsters a slight brownish appearance in the "knuckle."

THE QUALITY OF THE TIN PLATE.

There is another matter of some importance to be considered, that is, whether a saving cannot be effected in the quality of the tin plate used. For several years packers have held the opinion that much of the difficulty could be avoided by using a plate with a heavy coating of tin. Experiments were therefore made with the view of determining if the quality of the plate had any such influence. Now for the manufacture of 1,000 one-pound cans, including covers, it requires 532 sheets of tin-plates 14 by 20 inches or 4¾ boxes, there being 112 sheets to the box. On August 5th, Bessemer Cokes were quoted at 9s. 6d. f.o.b., Swansea and Charcoals at 13s. 6d., a difference between the two qualities of 4s. a box, or 19s. per 1,000 cans. Placing the annual output of lobsters at even 200,000 cases, equal to 9,000,000 cans, the difference in cost in tin-plate alone amounts to £9,120 or about $45,000. An independent estimate based upon the price of tin plate laid down in Charlottetown places the difference at $3.25 per 1,000 cans, equal to $31,200.

A large number of cans made of tin-plate representing these two grades were packed and careful observations made upon the results.

The conclusion to which we have come upon this important matter is that no necessity exists for a very high grade of tin-plate.

In the early days of the industry the material used was iron-plate instead of steel plate as at present. Three years ago several packers, thinking the deterioration was in some way bound up with the use of steel reverted to the former practice, at a very considerable expense, but they could observe no difference in the results. Then they imported a very heavy grade of plate at a material advance in cost, but with no corresponding profit, as has already been pointed out.

BACTERIOLOGY.

It is unnecessary to overload a report of a practical nature with technical details of bacteriologic work or dwell upon the difficulties encountered in it, because they are of a purely scientific interest and of little value to those whose first business is to pack good lobsters. Besides, it is questionable to what degree such studies should be prosecuted in a departmental inquiry. The main object was kept continually in view, to provide a remedy and there would certainly be no justification in delaying the report for the sake of attaining to a scientific completeness of detail. This is the more true since the working out of these scientific requirements can be done at one's leisure and has no heavy bearing upon the business in hand.

Only so much then is introduced as will serve to show the method of working; concerning the difficulties they are only such as are incident to all original bacteriologic inquiry. It may be noted, however, that much labour was spent upon obtaining suitable media. Many organisms refused entirely to grow upon the media usually employed and it was not until there was substituted for the ordinary peptone-gelatine and nutrient agar a preparation composed of lobster bouillon and agar, that success resulted.

An exhaustive series of plate cultures was made from a large number of cans with the object of isolating the bacteria infesting the tissue, to identify them and to study their growth and life history. Finally, four micro-organisms were obtained in pure culture. These were taken and in turn they were introduced into sterile cans, where they were allowed to grow. F these cans, again, pure cultures were obtained similar to those which were introduced. Lastly, these bacteria produced in the sterile cans, conditions similar to those observed in the cans from which they were originally obtained.

Of these four micro-organisms, the statement is made provisionally, that they have not been hitherto isolated or described. The further study of these forms and the proving of this provisional statement is the scientific work referred to, for which it was not thought justifiable to further delay the present report.

The following brief account is extracted from the notes of the work done in the research laboratories of the conjoint board of the Royal College of Physicians, London, and the Royal College of Surgeons, England (January, 1897.)

The organisms are named I., II., III., IV., provisionally.

Fresh inoculations were made in London with the following results.

I

Fourth day.—Gelatine tubes all show a similar growth, well marked in the whole course of the stitch, wide at the top with serrated edges, the surface slightly depressed, but no liquefaction. The growth is folded in two places. One inclined agar tube shows a faint streak, the other yields no results; the tubes are now placed in the incubator at 20° C.

Fifth day.—All growths are more apparent.

Sixth day.—The surface of the gelatine tube is depressed and smeared, the growth has descended leaving a transparent ovoid filmy body 1 cm. long which connects with the main growth. The stitch is wide, the edges rough with distinct colonies and the whole growth rotated in spiral form.

Seventh day. Heavy growth in both gelatine tubes, the globule at the top is now conical at the edges of the stitch, the colonies are discrete. No liquefaction of gelatine. Both agar tubes show distinct though fine growth.

Eighth day.—Heavy growth, surface extension, with distinct edge and glistening pearly appearance. Stitch much expanded, filmy and tubular at top, quite transparent. One-quarter way down, the growth is opaque and dense, becoming filmy again and finally dense in the lower quarter. The end is pointed and the edge serrated: agar tubes show discrete, white moist colonies.

Ninth day.—Surface growth extended and moist: two-thirds of the stitch is expanded, tubular and filmy: the bottom very dense.

Tenth day.—Three-fourths of the stitch are now tubular: the lower part very dense and opaque: no liquefaction.

Eleventh day.—All these characteristics more marked.

Twelfth day.—Gelatine liquefying, surface growth extending.

Thirteenth day.—Gelatine cupped and liquefying.

Fourteenth day.—Gelatine liquefied and growth diffusing throughout the tube.

Microscopic examination with No. 4 ocular and $\frac{1}{12}$ oil immersion lens: pure culture, rods of varying length and thickness, some slightly curved and others so short as to resemble cocci. No sporulation was observed. In hanging drop No. I is slowly motile with an undulatory movement.

Grows in hydrogen. Coagulates milk. Forms gas.

II.

Fourth day.—The gelatine tubes show a growth in the whole course of the stitch with a rather smooth edge, the growth transparent and not liquefying. One inclined agar tube shows a faint growth. The other none.

Fifth day.—Growth more marked. Tubes placed in incubator at 20° C.

Sixth day.—No surface growth: the stitch transparent, edges smooth and filmly. Agar growth very indefinite.

Seventh day.—Gelatine tubes show increased growth: the edges filmly and wavy. No liquefaction.

Eighth day.—The stitch is wide, the edges more undulating and filmy. No liquefaction.

Agar, very fine wide transparent growth, quite marked in both tubes.

Ninth day.—Gelatine not liquefying, no surface growth: stitch retains its characteristics. Agar growth more visible.

Tenth day. Gelatine tubes: growth more marked.

Eleventh day. Cupping of surface. Agar, growing.

Twelfth day.—Agar, very fine transparent colonies: confluent and glistening, gelatine, cupping of surface, no surface growth, stitch wider, wavy border with lateral offshoots which are fine and filmy. During the next three days the cupping becomes more marked, the stitch wider, the border more wavy and the offshoots prominent, but no liquefaction. The agar tubes exhibited the same characteristics.

Microscopic examination: pure culture of cocci, in chains and clusters, the chains very fine, simulating spore-forming bacteria, the clusters composed of from three individuals to a mass impossible to count.

Coagulates milk: grows in hydrogen.

III.

No growth at room temperature. The tubes were placed at 20° C, where they remained for four days, when growth was visible in agar, there being ten colonies upon the surface of one tube and twelve on the other. The colonies large and distinct, with a dark centre and transparent border. The agar tubes were placed at 37° C. when the growth became very rapid, the colonies confluent, and exhibiting one wide transparent growth with sinuous borders. From this a gelatine tube was inoculated and in two days showed a distinct growth, with a wavy border, translucent, but none upon surface. In two days more, one colony appeared upon the surface of the gelatine tube and the stitch was white and dense with here and there offsets radiating outward in long transparent points. After ten days, the gelatine began to liquefy.

Microscopic examination: pure culture, a fine long rod, straight or very gently curved, the individuals with no special relation to each other, but in many cases joined end to end, to form very long, straight, and wavy threads, at least ten times the length of the single rod. The rod shows refractive bodies not to be distinguished from spores.

This organism, when examined in the hanging drop, is slowly motile and shows a nail-shaped head, dark and round, the tail undulating slowly. In a young growth no threads are visible. During eighteen hours, the same hanging drop was kept under observation upon a warm stage, when end spores appeared in nearly every rod and motion still persisted. A cover glass preparation was made from this hanging drop, the rounded end had lessened in size under the process of staining, but free spores were observed, and some just breaking from the organism.

Coagulates milk. Grows in hydrogen.

IV.

Fourth day.—Gelatine tubes show a depressed surface with pale smeared growth. The stitch is wide above and curves to a point below, as a series of small discrete yellow colonies in a line.

Sixth day.—Surface smeared, depressed, stitch growth sunk downward, leaving a globule at the top, joining with the stitch which tapers to a point.

Seventh day.—Surface growth, glistening, radiating with distinct edges, transparent. Stitch descending, globule becoming larger, colonies at bottom, still distinct and tapering to a fine point.

Eighth day.—Extensive transparent growth on surface: upper part of stitch trumpet-shaped for one-fourth of its length, remainder conical, the bottom composed of distinct colonies.

These characteristics became more marked till the twentieth day, when the gelatine was completly liquefied.

This organism forms gas, coagulates milk and grows in hydrogen.

[illegible] cultivation: pure cultures, fine short rods, straight, single or in pairs, lying at [illegible] with each other. No spores visible; many coccilike forms of the rods, the length is almost uniform.

In hanging drop this bacillus is actively motile. The four micro-organisms were stained, mounted permanently and photographed. The tubes were all drawn to scale as colour.

A chemical examination was undertaken to determine the products of their growth, and up to the present there have been isolated,

Indol,
Butyric acid,
Lactic acid
Methylamine, and dimethylamine.
Sulphuretted hydrogen, and
Carbon dioxide.

The following observations were made incidentally. Upon the paper linings, concretions were found: these were composed of sodium chloride, calcium chloride, tyrosin and epithelial cells. The jelly like covering of tissue in cans so much desired is due to fat tinged with pigment. Add ether, evaporate, there are left fat drops tinged with pigment and a feathery phosphate of lime. No fat crystals were obtained by filtering through a wet filter.

THE REMEDY.

Even if as yet we were apparently no nearer to the end, namely the providing of a remedy for all these evils we at least had a clear view of the problem.

1. The various forms which the deterioration assumed were observed.
2. The various causes of it were ascertained.
3. The degree of dependence of one cause upon another was determined.

The case might be stated thus. The deterioration was proved to be due in the main to putrefaction, and putrefaction to be due to the operations of micro-organisms. These micro organisms could only be destroyed by heat, but it was experienced in the past that when a sufficient heat to destroy them was employed, the tin plate also was liable to be damaged and chemical changes at once ensued which became more marked as time went on. Therefore we now come to the main question.

What means are to be employed by which lobsters may be placed in cans with the assurance that they will retain their good qualities of flavour, texture and appearance for an indefinite period and under all climatic conditions?

The use of germicidal fluids such as salicylates, borates and others with germicidal properties may be dismissed at once. In many cases they are poisonous and in most cases they injure the quality of the food stuff to which they are applied. In the preservation of lobsters, such poisonous substances find no useful employment.

The only process that remains is the use of heat as a sterilizing medium, but that heat must be applied in such a way as not to injure the quality of the meat or the can in which it is contained. At the same time it must be sufficient to destroy [illegible] teria and their spores.

The general principles underlying the sterilization of media were first enunciated by Professor Tyndall in 1878. He says: "I had several cases of survival of bacteria after four and five hours' boiling. Thus far has experiment actually reached, but there is no valid warrant for fixing upon even eight hours as the extreme limit of vital resistance. Probably more extended research would reveal germs more obstinate still. An infusion infected with the most powerful resistant germs but otherwise protected against the floating matters of the air is gradually raised to the boiling point. Such germs as have reached the soft and plastic state immediately preceding their development or bacteria are thus destroyed. The infusion is then put aside in a warm place for ten or twelve hours. We then raise the infusion a second time to the boiling temperature which as before destroys all germs then approaching their point of final development. The infusion is again put aside for ten or twelve hours and the process of heating is repeated. We thus kill the germs in the order of their resistance ond finally kill the last of them. No infusion can withstand this pro-

cess, if it be repeated a sufficient number of times. By this method of discontinuous heating, three minutes were sufficient to accomplish what three hundred minutes of continuous boiling failed to accomplish.

Professor Tyndall also pointed out that a temperature much lower than that of 212 degrees Fahrenheit may suffice to destroy bacteria and it was this principle which Pasteur worked upon and to which the name of Pasteurisation is applied.

A degree of heat which will destroy bacteria is entirely insufficient to destroy their spores. Many bacteria will not grow if the temperature is at high as that of the human body. Some will live at a freezing temperature while the spores of others may resist the action of boiling water for five or six hours. As a matter of fact, the packers have proved by years of costly experiments that an exposure of two hours and a half to a temperature of boiling water will not in many cases destroy all the spores which infest the lobster tissue.

Having in mind the prominent part which bacteria were proved to play, it remained to apply the principles of sterilization as laid down by Tyndall to the preservation of lobsters. That is to say, the degree of heat to be employed, the duration of the application and the number of successive exposures to destroy the bacteria. Ordinarily, this is done by heating a test tube containing the bacteria in a water bath and noting the results. But the temperature conditions in an open test tube are entirely different from those which one finds in a sealed can filled with a solid material. Therefore, as a preliminary measure it was necessary to determine the length of time required to raise the temperature of the contents of a sealed can to the temperature of the medium in which that can is immersed. To this end, an apparatus was constructed, consisting of a can through the cover of which a well closed at the bottom, was introduced into the interior. An air chamber was soldered on top, pierced so as to allow a thermometer to be carried down the well, which was filled with oil, into the can. The can was now filled with lobster and sealed. The apparatus was then placed in a vessel of water which was kept at 100° C.

The following table shows the result:

"HALF-POUND FLATS."

Time in Minutes.	Temperature C°
5	22
10	44·5
15	54·5
20	65
25	76·5
30	86
35	92
40	94
45	96
50	97
55	97·5
60	98

"POUND FLATS."

Time in Minutes.	Temperature C°.
5	22
10	50
15	56
20	68
25	78
30	85
35	90
40	94·2
45	97
50	99
55	100
60	100

From this table it appears that it requires at least half an hour to raise the contents of a can to near the boiling point, allowing for radiation and imperfections in the apparatus. It would be easy to determine the time with scientific accuracy with a platinum electro thermometer, but an instrument of this delicacy was not accessible and the above results are sufficiently accurate for practical purposes.

From the experiment of Pasteur, it was shown that many forms of bacteria are destroyed by a temperature of 57 degrees C. applied for half and hour, and that if this were repeated *three times*, the medium became sterile. From test-tube observation, it was observed that the bacteria of the lobster was not of so delicate a constitution and the heat with which we commenced was 80 degrees, applied *three times* at intervals of 24 hours. All the cans so treated were a failure. Next 85 degrees was used, this also failed. Then a temperature of 90 was employed: some of the cans so treated remain good up to the present time, while cans treated with 95 nearly all remained good. With special precautions, a temperature of 95 C. equal to 204 Fahrenheit will suffice. But as it is not possible in practice to convert a lobster factory into a bacteriologic laboratory, the problem ever present was to simplify the process. If 95 was accepted as the standard, it would involve the use of the thermometers and automatic temperature regulators. If a temperature of above 100 C. or 212 Fahrenheit was adopted, it would necessitate the use of autoclave retorts which very few factories possess, and which are beyond the reach of many worthy men. Therefore, all experiments were continued at a temperature of 212 degrees or that of boiling water, which yields excellent results. If it is theoretically less perfect than a temperature of 195 degrees, it is attended with no such risks as might be associated with the employment of lower temperatures. Following these lines, and acting upon the information thus gained, a fresh pack was made and the observations upon sterilization resumed. It is not necessary here to mention the series of failures which led up to satisfactory results. There were four factors to consider: the degree of heat, the time of exposure and the interval between them. From a full consideration of all these, we conclude as follows in the case of pound cans:

1st. Apply the temperature of boiling water for one hour.

2nd. After 12 to 15 hours, apply the same heat for 50 minutes.

3rd. After another 12-15 hours, apply the same heat for 40 minutes.

This makes two hours and a half immersion in boiling water, but from the table it appears that it takes about half an hour each time to bring the contents of the cans to the same temperature as the medium in which they are immersed, that is one hour and a half so that the lobster tissue has less than an hour's boiling divided into three separate periods of twenty minutes each.

4th. As a special precaution, in very warm weather, or in very badly infected localities, it is advisable to give a fourth boiling of 30 minutes at the expiration of another 12 hours.

In the case of half-pound cans, the time may be reduced to fifty minutes, forty minutes and thirty minutes. Cans treated in this way have all remained perfectly bright for 15 months, the fish is firm and white, the skin brilliantly red and the flavour as good as in fish fresh from the shell. Indeed, the only "defect" that can be pointed out is that the flesh is rather hard. This is due to the fact that it is under boiled, and would permit of being heated again by the cook before serving. It has in fact been boiled for less than an hour.

In warm weather, the cans require to be cooled rapidly after each boiling. This can best be done by the application of ice, but a stream of cold water will do equally well. They should be kept cool by the frequent application of cold water in the intervals between boiling. Those who keep them coolest will get the best results.

CLEANING THE CANS.

There is very little profit in keeping the lobster tissue free from contamination, if the cans themselves are not cleansed. No cans, as they come into the factories are clean enough for use. Those which have been soldered with rosin have a layer of that substance upon the bottom, when heat is applied the rosin volatilizes and permeates the

meat with its odour. Workmen have a habit of carrying the cans by placing their fingers inside and grasping four at a time. If they have been using flux and solder the stains are transferred to the bright tin.

It has been already pointed out that the best flux for making cans is acid because it is clean. If rosin has been used, the excess must be removed by turpentine. The whole inside of the can is to be thoroughly rubbed with some cleansing material such as hot soap and water, a solution of soda, or perhaps best of all a cloth moistened with methylated spirits. A gallon will suffice for a hundred cases. It would be easy to arrange some kind of revolving brush which might be kept moist with the solution. The cans are next to be passed through clean, fresh water and wiped dry. Then they are to be kept clean by turning mouth down upon a clean table. The covers are to be treated in the same way.

When the meat is removed from the shell, it is to be received in pans which have previously been washed in boiling water. The claws and arms are to be washed in fresh well water, upon no account in sea water. Those who are anxious to obtain the best results, will make the last washing in water which has been boiled and cooled. The tails should be split upon the front and every trace of the gut removed; if this precaution is neglected, no good results can be expected. The meat should be gently pressed and allowed to drain quite dry, being covered over with pieces of cotton just removed from boiling water. It is then to be placed in cans, directly by hand. If a cylindrical machine is used it should be boiled immediately before using.

It is quite useless adopting these precautions unless the hands of the employees are clean, and packers who value their results, will attend to this procedure, though it may appear to be an unnecessary refinement.

REMOVING THE AIR.

In the section upon sealing, it was pointed out that to facilitate the process, a small hole should be left in the cover, and that before this hole is closed the cover should be pressed down as closely as possible to the contents, that in short, the can should be concave, for this is all the "conceaving" the can is to receive. This can perhaps best be done by means of a lever worked by the foot.

We next come to a matter of equal importance, the removal of the air from the can after the first bath by puncturing the tin. In a word, it may be said, not only that this process is useless, but a long series of investigations proves that it is one of the main causes of deterioration. If a series of cans packed in the ordinary way be opened immediately after the second bath, the following condition may be found in nearly all cases. There is a purplish discoloration upon the inside of the cover, extending down the side in a limited area and over the inside of the bottom of the can. In marked cases, it is of an intense metallic hue and often arranged in a beautiful pattern. This discoloration appears instantly and has no connection with bacterial activity. The origin and remedy for this condition was discovered during a separate line of investigation, of which the following are details.

It is well known that some forms of bacteria thrive only in the absence of air: now, the process of probing the cans would create that very condition. If the bacteria found in the cans are of this nature, it follows that this practice merely creates the conditions favourable to their growth. To test this reasoning, a can was filled with lobster meat, it was boiled for an hour and a half, it was not probed but was boiled again for another hour. When this can was opened, to test its sterility, to our gratification and surprise it was found entirely free from discoloration. It may further be said that up to that time, its nature and origin had baffled every effort at analysis. This occasion however, was seized and to determine the conditions under which this blackening occurs, the following experiments were made:

Five cans were taken and treated as follows: One was sealed empty, one was filled with distilled water, one with a saturated solution of common salt and water, one with lobster meat, and another with the same material. These were numbered respectively, one, two, three, four, five. They were all boiled for one hour and a half at

a temperature of 100 C., and then allowed to cool. Number five was probed and all were returned to the bath for another hour and a half at the same temperature. Upon examination, number one was found unchanged, number two was very slightly rusted where the raw edge of iron came in contact with the water, number three was more rusted, number four was unaltered, but number five, the one which had been probed, showed the discoloration above referred to.

Four hundred cans were then packed and heat applied at 100 C., for periods varying from 1½ to 3 hours, and in no case did this discoloration appear when the cans were not probed. Again, all packers state this discoloration appears only after the second bath, that is after the cans have been probed. If then, this defect is caused by probing, as is clear, it remained to consider how cans might be packed without having resort to this practice which is universally employed.

Upon further examination of the question, no reason can be discovered for this practice. Flasks of media from which the air is not expelled are kept from putrefying in laboratories for years, if only that air is free from germs, and further, air is allowed to enter those jars with no ill effect if only the air is filtered through cotton wool to free it from germs. Therefore, in all subsequent work, the cans were not probed, and this is an essential part of the process.

The sign of deterioration most readily observed is a bulging outwards of the ends of the can. There is reason in this since this bulging is due to the accummulation within of the gases incident to putrefaction, as a result of bacterial activity. If now the cans are not probed, there will be less concave than usual and will simulate blown cans. This appearance may be reduced by pressing the cover well down in the centre, before soldering the air hole. The force of this objection was anticipated, and, absurd, as it may seem, to explain this appearance was one of the reasons for an extensive visit to the English market, as will afterwards appear.

The old test of tapping the cans with a piece of metal has always been an imperfect one, in future, it will be equally imperfect, but it will be unnecessary since no can will blow if properly packed. In any case the objection is disarmed since it is explained that no extreme degree of concavity is required. On the contrary, a highly concaved can, in future, is to be regarded as a can which will probably develop "smut."

On the 25th of August last, the results were submitted to the Minister of Marine and Fisheries, and to Professor Prince in Ottawa. It was then admited that if lobsters could be placed upon the market of the same quality as those submitted, and if they would retain under all conditions of climate and season, the qualities therein observed, of colour, texture, flavour and general daintiness of appearance, the problem would be solved. The question asked was, "Will they so keep?" and the answer, "Time alone can settle." We have now the experience of fifteen months, and after that period no deterioration is observable.

From the time that some degree of success began to attend our efforts, samples were regularly submitted to experienced packers for criticism of the quality. This examination was continued for a period of five months. The samples were found satisfactory, "if they would only keep." To test the keeping qualities, the following procedure was adoped. A number of cans were placed in an incubator, which was kept at a temperature of 37 degrees C., equal to 100 degrees Fahrenheit constantly for two months. The cans were shaken from time to time to imitate the conditions they would have to encounter upon a sea voyage. At the end of the test they were examined, and no deterioration was observed. At the present time, cans fifteen months old were opened and no signs of alteration can be detected.

Throughout the whole inquiry, we have been guided only by facts proven to be so, we have actual evidence that cans remain in perfect condition for over a year: every day increases our knowledge as to how long they will so remain. There is, however, nothing to show that they will not remain in perfect condition for an indefinite period.

Having knowledge of the fact that a large market and particularly the English market is very conservative as to the introduction of new processes, the Minister of Marine and Fisheries considered it advisable that personal interviews should be had with the principal importers in England. At the same time, some bacteriological

problems were to be further dealt with in the laboratories of the Conjoint Board of the Royal College of Physicians, London, and the Royal College of Surgeons, England, the Director of which, Dr. Sims Woodhead, afforded every opportunity for work. This portion of the work is considered in another section.

Accordingly, he directed me to proceed to London on the 15th December, where communication was had with the High Commissioner for Canada. It is worth pausing to refer to the admirable arrangements which were effected by Sir Donald Smith and the Secretary of the Commissioner, Mr. J. G. Colmer, C.M.G. These gentlemen wrote to as many importers as could be waited upon and without exception they expressed a willingness to aid us with advice and criticism. They redeemed their promise to the fullest extent. Lack of time alone prevented me from availing myself of the co-operation of the Liverpool dealers.

Interviews were had; test cans were opened and examined. The needs of the English market were considered. An opinion and criticism of the product were obtained. This opinion and criticism, judiciously intermingled, is contained in the following letters to the High Commissioner, whose Secretary, Mr. Colmer, so capably conducted the correspondence. This is also a fitting place to make mention of the willing aid given by Mr. L. Wurzburg and Mr. Weston, of Messrs. Powell Bros. & Co., and Mr. Fowke, whose knowledge made the way easy.

In the following letters only some personal matters are omitted to bring them into harmony with a formal report, and it is thought best not to interfere with the text of the letters. They are submitted in the sense in which they were written, as an expression of opinion by competent judges upon what they had seen. Their judgment, however, need bind no one; any packer may satisfy himself by repeating the experiments in canning according to the method here set down.

POWELL BROS. & CO.,

No. 27 MINCING LANE, LONDON, January 14, 1897

Sir DONALD A. SMITH, K.C.M.G.,
High Commissioner for Canada,
17 Victoria St., S.W.

SIR,—Dr. Macphail has submitted to my inspection several samples of 1 lb. Flat Lobsters, which he informs us were packed by him in June last.

The fish was perfectly clean and bright, while there was absolutely not a trace of "smut" or black, nor was the can in any way discoloured by the action of acid on the tin-plate, and we might add that the flavour and texture of the meat left nothing to be desired. We are the more surprised at this, as Dr. Macphail informs us that these samples were packed in a district noted for the great percentage of cans which develop black and "smut."

Should Dr. Macphail have found a means of canning lobsters simple to every packer, which absolutely does away with smut in the can, or the lobsters turning black, it will be of inestimable benefit to the whole industry.

We have the honour to remain, sir,
Your most obedient servants,

POWELL BROS. & CO.

CROSSE & BLACKWELL, LIMITED,

LONDON, January 12, 1897.

Sir DONALD SMITH,
Victoria Street, S.W.

DEAR SIR,—We had the pleasure of a visit from Dr. Macphail yesterday, when he showed us a tin of lobsters preserved by an improved process. The appearance and quality were excellent and showed a marked improvement upon the qualities shipped here for some years past.

We hope that the Canadian Government will follow out these experiments and so revive a large and important industry which has been gradually diminishing for some years, on account of the uncertain out-turn of the tins.

We are, yours faithfully,

THOMAS F. BLACKWELL.

No. 4 Fenchurch Buildings.

London, E.C., January 7, 1897.

The High Commissioner for Canada,
No. 17 Victoria Street, S.W.

Sir,—We have seen to-day a can of lobsters preserved by Dr. Macphail during the first week of June last. We understand that these lobsters were taken on the shore of Prince Edward Island, a district notorious for producing hitherto a quality always more or less deteriorated by the presence of so-called black smut and inferior flavour.

The can opened before us was not only absolutely free from the defect just referred to, but the colour, tissue and flavour of the meat resembled the fresh article in a remarkable degree, quite unattainable by the present methods of canning the crustacea.

If this process can, as we are assured, be adopted in the factories without incurring great additional expense, the business in this article will not only, as a natural consequence become more satisfactory to everybody concerned, but very large sums of money will annually be saved, which hitherto have been lost either through depreciation or confiscation and complete destruction of many parcels shipped to Europe.

It seems to us that Dr. Macphail has solved the problem in a manner which must far surpass the most sanguine expectations which might have been entertained.

We have, etc.,

M. L. WURZBURG & CO.

E. Lazenby & Son, Limited.

No. 18 Trinity Street,
London, S.E., 14th January, 1897.

To the High Commissioner for Canada,
No. 17 Victoria Street, S.W.

Sir,—We were favoured with a visit from Dr. Macphail on Monday last, when he showed us samples of canned lobsters, packed by himself, some eight months or so ago. As far as we could see, there was not the slightest trace of discoloration, either on the fish or in the interior of the tins in which it was packed.

Dr. Macphail's system of preserving seems to have been perfectly successful, and if it is a practical one, great benefit should be derived from it by canners and others interested in the trade, for undoubtedly great harm has been done by the numbers of tins that come to this country every season, the contents of which are either wholly or partially discoloured.

We are, sir, your obedient servant,

E. LAZENBY & CO., Ltd.

Henry W. Peabody & Co.

No. 5 East India Avenue,
London, 15th January, 1897.

Sir Donald A. Smith,
High Commissioner for Canada,
Victoria St., S.W.

Sir,—We yesterday had an opportunity of inspecting a sample of canned lobsters packed by Dr. Andrew Macphail with a view of showing how the pack of these goods can be improved in Canada. That there is a very great necessity for improvement in

the present methods is an undoubted fact, especially so far as fish put up in Prince Edward Island, New Brunswick and parts of Nova Scotia are concerned. In consequence of the uncertainty of the out-turn of the goods from these districts, we may say that it is now customary here for buyers to inspect and sample a large proportion of each parcel before buying, necessitating considerable expense and loss of cans to the packers. The sample which Dr. Macphail submitted to us opened as near perfect as possible with regard to flavour and appearance, and if fishermen can be educated to pack lobsters on the basis of Dr. Macphail's investigations, the demand in this country for canned lobsters will be increased.

Prices now obtainable for the high-class goods packed on the south shore of Nova Scotia and in Newfoundland would no doubt also be paid for lobsters put up under this system in Prince Edward Island and other parts of Canada, where it has always been claimed that in consequence of the shallow water and muddy bottom, it has been impossible to can lobsters to the same perfection as in the districts referred to above.

We are, sir,
Your obedient servants,
HENRY W. PEABODY & CO.

A. W. LATHAM & CO.

No. 17 PHILPOT LANE,
LONDON, E.C., 12th January, 1897.

To the High Commissioner for Canada,
Victoria Chambers, Victoria St., S.W.

DEAR SIR,—We have to-day had the pleasure of seeing Dr. Macphail, of whose visit you advised us by your letter of the 7th instant, and who has submitted to our judgment, a sample can of preserved lobsters, which he tells us were processed according to his own system, and we can but say that we are very pleased with the appearance of the fish, which has retained its brightness of colour, and freshness of flavour, and considering that he has used the poorest kind of lobster found in Prince Edward Island waters, we would say that provided the saltness is got rid of, the result ought to be a very desirable article, when fish is used, caught on the Atlantic Coast of Nova Scotia or Newfoundland.

We think the Canadian Government has taken a step in the right direction, in commissioning these scientific gentlemen to investigate and improve on the present methods of canning, and thereby free the industry from many of its imperfect productions, and we, as interested parties, sincerely hope that they will see fit to continue these researches, and so help to make canned lobster, a sound, safe and wholesome article of food, which is at present by no means altogether the case.

We shall be glad to receive a copy of Dr. Macphail's printed report of the result of his experiments, and we remain,

Yours faithfully,
A. W. LATHAM & CO.

W. & D. HARVEST.

DOWGATE DOCK, UPPER THAMES STREET,
LONDON, E.C., 12th January, 1897.

To the Honourable
Sir DONALD A. SMITH, G.C.M.G.

DEAR SIR,—With further reference to your letter of the 7th inst., we have to-day seen Dr. Macphail, and after an exhaustive examination of his process of preserving canned lobster, and also of the results of such process, we have come to the conclusion that his experiments will result in great benefit to the packers, dealers and consumers of this, up to now, unprofitable article of commerce, and beg to remain.

Yours most respectfully,
W. & D. HARVEST.

SAMUEL HANSON, SON & BARTER.

No. 47 BOTOLPH LANE,
LONDON, E.C., 12th January, 1897.

Sir DONALD SMITH, G.C.M.G.

DEAR SIR,—We must express our satisfaction on finding the Canadian Government propose to take steps to improve the process of canning lobster, and we were pleased to see Dr. Macphail and hear his explanations as to the causes which give rise to the present unsatisfactory state of things.

We were favourably impressed with a sample shown to us by Dr. Macphail, which had been packed in a district from which we have, of late, received lobster of a poor quality.

If this is an indication of what can be done by careful and scientific process, then, all we need say is, that no time should be lost in bringing it under the notice of the packers.

Believe us, dear sir, yours faithfully,

SAMUEL HANSON, SON & BARTER.

JOHN PITCAIRN & SONS.

No. 7 UNION COURT, OLD BROAD STREET,
LONDON, 15th January, 1897.

Sir DONALD A. SMITH,
High Commissioner for Canada,
Victoria Street.

DEAR SIR,—I had the pleasure of seeing to-day some of the cans of lobsters packed by Dr. Macphail. It is my opinion they are far superior to anything I have seen packed in my experience of ten to fifteen years.

The appearance, flavour, taste are excellent, and in my opinion is all that can be desired. If goods can be packed like these, the serious difficulties we have had in the past will be overcome and hundreds of thousands of dollars will be saved to the packers and exporters.

I remain, yours respectfully,

G. H. TOOMBS,
of Charlottetown, P.E.I.

JOSEPH TRAVERS & SONS.

No. 119 CANNON STREET,
LONDON, E.C., 15th January, 1897.

Sir DONALD SMITH,
High Commissioner for Canada,
No. 17 Victoria Street, S.W.

DEAR SIR,—We have pleasure in reporting on the improvements in lobster packing, as suggested by Dr. Macphail.

We are glad to learn from Dr. Macphail that the lobster which he showed us had been packed in a district where the fish which turns black in the tin is more frequently found, and we consider that his experiment with this description of lobster showed a decided improvement on the method of packing at present in vogue, particularly, as far as the colour of the lobster was concerned.

We suggested to Dr. Macphail, that the flavour was in our opinion, not equal to the standard of some of the fine qualities of Newfoundland particularly, nor do we think that the fish in its present form, would immediately take the place of the fine quality that we referred to.

We are criticizing Dr. Macphail's process from a very high standard, which we understood from him was what he wanted. An important difficulty connected with his process, which Dr. Macphail pointed out, was the sounding of the tins, which was very similar to the sound emanating from the tin when it is what is known, to the trade, as "doubtful," which means that it is expected, sooner or later, to become "blown" or "swelled," the latter being the American phrase for this condition, and it would probably take some time to remove this prejudice, if this system were adopted; but we are of opinion that it would ultimately be overcome, provided the new system of packing was regarded by the trade as being successful in other particulars.

We are glad to hear from Dr. MacPhail that his principle includes an improvement in the grading of lobsters, which has been a great difficulty with distributors, and also must have been very detrimental to the general welfare to the trade, and we should be heartily glad to hear that he has been able to introduce a system which would enable us to depend on the regularity of the quality.

We are also glad to hear that the improved method would enable the trader to guarantee the lobsters to be sterilized and absolutely degerminated, which we think would provide distributors with a very strong argument for the purposes of pushing the trade and ought to result in an improvement in the consumption. We repeat that we pointed out to Dr. Macphail, that the consumers in this country wanted nothing better than what is packed at present by some of the best canners, and if he is successful in bringing the commoner quantities up to this standard, the result would undoubtedly be a perfect success.

The important points to be always borne in mind are, that the fish must be perfectly free from black smuts, that the liquid in the can should be as small a proportion as possible, that the meat should be as little broken as possible, and that the parcel should be graded uniformly.

We should be glad to know if we should be able to print on our labels that lobsters packed under this new system would be guaranteed by the Canadian Government to be absolutely free from all obnoxious germs or poisonous matter of any kind, and we think if the system were advertised as a new one backed up with this guarantee, it would remove a great deal of the prejudice which has been brought about through lobsters of indifferent qualities, and also improperly processed having been sold.

We shall be glad to hear of Dr. Macphail's success, and we are quite willing to support any new idea, which is in the nature of a permanent improvement.

We are, dear sir,

Yours faithfully,

FOR J. TRAVERS & SONS, LTD.
E. BOWON.

AUSTIN, NICHOLS & CO.

NEW YORK, December 14, 1896.

The Honourable the Minister of Marine and Fisheries,
Dominion of Canada.

DEAR SIR,—At the request of Dr. Macphail we examined a sample of lobster canned by him experimentally to show the quality of fish which can be produced under a special process on which he has been experimenting.

We take pleasure in stating that we consider this finer in quality, the fish being firmer, of a better colour and more desirable than the average quality of canned lobster that we receive from the Dominion. Lobster, if canned equal to this sample, would command a higher price in our market, than such goods as we have been receiving from the Dominion for the past few years.

Respectfully yours,

AUSTIN, NICHOLS & CO.

The buyer for the American firm was not prepared to give an expert opinion upon the product till he would have an opportunity of examining many samples packed a long time. The communication of the Cunningham & De Fournier Company has already been alluded to.

CONCLUSION.

I have merely stated facts and given results, and have purposely refrained from giving "views" or "theories." The interests of a trade involving three and a half million dollars are not to be put in jeopardy for any theory no matter how closely reasoned. I have stated the causes of the deterioration, I formulate below the measures to be taken to prevent it, and have shown examples of what could be thus effected. I have added the opinions upon the product of men who have seen it and who are well qualified to judge. It now remains for each individual to judge for himself and decide whether he will put the matter to the test upon his own responsibility. In the course of a year's operation I have come in contact with so many men and received encouragement and assistance from them, that it is impossible even to mention them all by name. In Prince Edward Island the thanks of the whole industry, in so far as any good may be accomplished, are due to Messrs. Mathieson, Grant, Hazard, Tidmarsh, Farquharson, MacNutt and Longworth.

Last of all, it may not be out of place to say that while at times the perplexities of the inquiry were great, they would have been greater had it not been for the scientific enthusiasm of the Commissioner of Fisheries, Professor Prince, and for the liberality of spirit and generosity of hand experienced from the Honourable the Minister of Marine and Fisheries.

ABSTRACT OF METHOD RECOMMENDED FOR THE CANNING OF LOBSTERS, ON THE BASIS OF THE FOREGOING INQUIRY.

1. Boil the live lobsters twelve to fifteen minutes in sea water which is renewed daily. Page 18.
2. Cool on lime washed tables and break off as soon as possible. Page 15.
3. Pull the tails, remove the meat from arms and claws. Place separately in pans which have been cleansed in boiling fresh water. Page 15.
4. Front split the tail, remove every trace of gut, wash off green gland in cold fresh water. Page 15.
5. Wash a second time in fresh water which has been boiled and cooled. (If the fresh water is taken from a fresh spring or deep pure well, this boiling is unnecessary.)
6. Place in earthenware dishes and cover with clean cotton which has just been boiled in fresh water. Allow to dry. Page 15.
7. Wash the claws in the same way, removing all coagulated blood and drain dry.
8. Cleanse all cans, removing rosin with turpentine, and all other stain with methylated spirits or other suitable fluid, wash in cold fresh water and wipe dry with clean cloth. Do not touch inside of cans afterwards with fingers. Pages 24 and 25.
9. Insert linings which must be kept free from dust in the original packages.
10. Place the salt in the can one to two teaspoonfuls to the pound, salt to be of the best quality.
11. Place the lobsters in the cans by hand, handling the meat as little as possible, with absolutely clean hands. Let the meat be quite dry.
12. Cover, wipe and seal at once.
13. Concave the cover as much as possible before the blow-hole is sealed, by pressing down the middle. Page 25.
14. Bathe at once, the pound cans, fifty minutes to one hour, the half-pound cans, forty-five to fifty minutes. The water to be fresh, renewed daily and must be boiling vigorously. Pages 17 and 24.
15. Remove and cool. Do not probe. Keep cool. Page 26.
16. After twelve to fifteen hours, bathe again, the pound cans fifty minutes, the half-pound forty minutes.

17. Remove and keep cool. Do not probe. Keep cool.

18. After twelve or fifteen hours bathe again, the pound cans forty minutes, the half-pounds half an hour.

19. Remove and keep cool, do not probe.

20. In very hot weather, repeat No. 18 after another twelve hours. Page 24.

21. Do over any leak and treat as a fresh can.

22. Before commencing "scald" in fresh hot water all vessels, tables, knives, forks, cloths, &c., which are likely to come in contact with the meat.

23. Let the shortest possible time elapse between breaking off and packing and between sealing and bathing. Bathe in small lots rather than wait till the day's catch, if large, is sealed.

24. Allow no bodies, refuse or other offal to accumulate about the factory or to be thrown into the water around it. Factories built in the water should have a free clean flow at every tide: those built on shore are to be kept clean as above mentioned, within and without.